

ished on more complete magnetisation, until at an induction of about 20,000 it became very small with every indication of disappearing altogether. Soft iron and hard steel gave very similar curves, and in both the curve of hysteresis-induction cut the curve obtained from the values in an alternating field at a point just before the maximum. The result fully bears out the deduction from the theory, and proves in addition that hysteresis is not sensibly due to anything of the nature of mechanical restraint of the molecules. The form of the curve also gives clear indications of the three stages of molecular movement, the first stage giving a slowly rising curve, the second a straight rapid rise, and the third a straight and much more rapid descent.

Further experiments were carried out on the effect of speed of rotation. In an alternating field the speed of reversal has been shown to be without sensible effect on the hysteresis, and theory points to this result as a natural deduction. The above apparatus was well adapted for testing the matter, since the hysteresis per reversal could be read at each instant independently of the speed. From an extremely slow speed up to 70 revolutions per second no definite change was found in the value of the hysteresis. At the same time several small modifications were noted, produced by rapid variations in the speed of rotation or magnetising force. The effect lasted through many revolutions, but ultimately the same steady condition was arrived at. At and near the maximum value the hysteresis was very variable. The effects were much more marked in soft iron than in hard steel, as would be anticipated from the theory of their constitution.

The experiments in their verification of an untried deduction form a strong proof of the validity of the molecular theory of magnetism, and throw some light on the nature of the molecular complex and of the interactions which take place therein.

“A Magnetic Detector of Electrical Waves and some of its Applications.” By E. RUTHERFORD, M.A., 1851 Exhibition Science Scholar, New Zealand University, Trinity College, Cambridge. Communicated by Professor J. J. THOMSON, F.R.S. Received June 11,—Read June 18, 1896.

(Abstract.)

The effect of Leyden jar discharges on the magnetisation of steel needles is investigated, and it is shown that the demagnetisation of strongly magnetised steel needles offers a simple and convenient means for detecting and comparing currents of great rapidity of alternation.

The partial demagnetisation of fine steel wires, over which is wound a small solenoid, was found to be a very sensitive means of detecting electrical waves at long distances from the vibrator. Quite a marked effect was found at a distance of over half a mile from the vibrator.

Detectors made of very fine steel wire may be used to investigate waves along wires and free vibrating circuits of short wave-length. Fine wire detectors are of the same order of sensitiveness as the bolometer for showing electrical oscillations in a conductor.

This detector also has the property of distinguishing between the first and second half oscillations of a discharge, and may be used for determining the damping of electrical vibrations and the resistances of the discharge circuit.

A method of experimentally determining the period of oscillation of a Leyden jar circuit by the division of rapidly alternating currents in a multiple circuit is explained. The capacity and the self-inductance of the circuit for high frequency discharges may also be deduced, so that all the constants of a discharge circuit may be experimentally determined. In the course of the paper the following subjects were investigated.

(1) *Magnetisation of Iron by High Frequency Discharges.*—The effect of the Leyden jar discharge on soft iron and steel is fully examined. Steel needles which had been placed in a solenoid and subjected to a discharge were examined by dissolving them in acid. It was found that there was apparently only evidence of two half oscillations in the discharge, and this effect is due to the demagnetising force exerted by the needle on itself during the discharge.

The effect of continued discharges on the demagnetisation of magnetised steel needles was investigated, and also the effect of varying the length and diameter of the steel needles.

When a discharge is sent *longitudinally* through a magnetised steel wire the magnetic moment of the needle is always decreased, due to the circular magnetisation of the wire by the current through it. This "longitudinal" detector, when of thin steel wire, was found to be a sensitive means of detecting electrical oscillations of small amplitude.

Both the "longitudinal" and "solenoidal" detectors may be readily used for comparing the intensities of currents in multiple circuits when traversed by currents of the same period.

(2) *Detection of Electrical Waves at Long Distances from the Vibrator.*—A compound detector needle was composed of fine steel wires and a small solenoid wound over it. When this detector was placed in series with the wires of a receiver, the electrical oscillations set up in the circuit tended to demagnetise the magnetised detector needle.

By this method electrical waves from a Hertzian vibrator were

detected for long distances. An effect was obtained at over half a mile from the vibrator.

(3) *Waves along Wires.*—The uses of fine steel wires for examining the distribution of currents along wires are explained.

(4) *Damping of Oscillations.*—A method of determining the damping of discharge circuits is investigated. The absorption of energy in spark gaps is deduced, and the apparent resistance of the air break to the discharge determined.

(5) *Resistances of Iron Wires.*—Quantitative results are given for the resistance of iron wires for very rapid alternations. The value of the permeability of the different specimens is deduced, and it is shown to vary with the diameter of the wire and the intensity of the discharge.

(6) *Absorption of Energy by Conductors.*—The absorption of energy of iron and non-magnetic cylinders placed in solenoid through which a discharge passed were determined. Iron cylinders were found to absorb much more energy than copper ones of the same diameter, and the permeability of the iron for the discharge is deduced.

(7) *Determination of the Period of Oscillation of Leyden Jar Discharges.*—A method of accurately determining the period of oscillation is based on the division of rapid alternations in a multiple circuit, one arm of which is composed of a standard inductance, and the other of a variable electrolytic resistance.

The value of  $n$ , the number of oscillations per second, when the currents in the branches of the multiple circuits are equal, is, under certain conditions, given by—

$$n = \frac{R}{2\pi W},$$

where  $R$  = resistance of electrolyte to the discharge,

$W$  = value of the standard inductance.

The value of the self-inductance and capacity of the discharge circuit for very rapid oscillations may also be experimentally deduced.

“Magnetisation of Liquids.” By JOHN S. TOWNSEND, M.A.

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The experiments on the coefficient of magnetisation of liquids were made with a sensitive induction balance. Both circuits were commuted about sixteen times a second, so that very small inductances could be detected by the galvanometer in the secondary circuit. The principle of the method consisted in balancing the increase of the